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THE BATS OF THE OUACHITA MOUNTAINS

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ABSTRACT

A survey was conducted from June, 1982 through January, 1989 to determine the occurrence of bat species in the Ouachita Mountain region of west-central Arkansas and southeastern Oklahoma, with emphasis on censusing lands managed by the USDA Forest Service, Ouachita National Forest. Seven genera and 13 species of bats in the families Vespertilionidae and Molossidae were captured. Species represented included: *Eptesicus fuscus, Lasionycteris noctivagans, Lasiurus borealis, Lasiurus cinereus, Lasiurus seminolus, Myotis austroriparius, Myotis keenii, Myotis leibii, Myotis lucifugus, Myotis sodalis, Nycticeius humeralis, Pipistrellus subflavus,* and *Tadarida brasiliensis cynocephala.*

INTRODUCTION

From June, 1982 through January, 1989 we conducted a survey of bat species occurring in the Ouachita Mountain region of west-central Arkansas and southeastern Oklahoma, with major emphasis on the Ouachita National Forest.

The Ouachita Mountains, located in west-central Arkansas and southeastern Oklahoma (Fig. 1), have been folded and vaulted as well as uplifted, exhibiting an east-west, ridge-and-valley landscape with elevations ranging from 80 to 860 meters above sea level. The soils, developed from sandstone, shale, novaculite and chert, are dry to droughty and range in texture from loam to clay (Pell, 1983). Second-growth (50-70 years old) mixed hardwoods *(Quercus/Carya)* occur on more mesic north slopes, with dryer south slopes vegetated by second-growth shortleaf pine *(Pinus echinata)* forest types. The region contains a significant number of rivers and streams, and several thousand small lakes and wildlife waterholes, all providing riparian foraging habitat. Almost all first and second order streams and some third and fourth order streams have intermittent flow during dryer summer and fall months. However, most third and fourth order streams are perennial (USDA Forest Service, 1983).

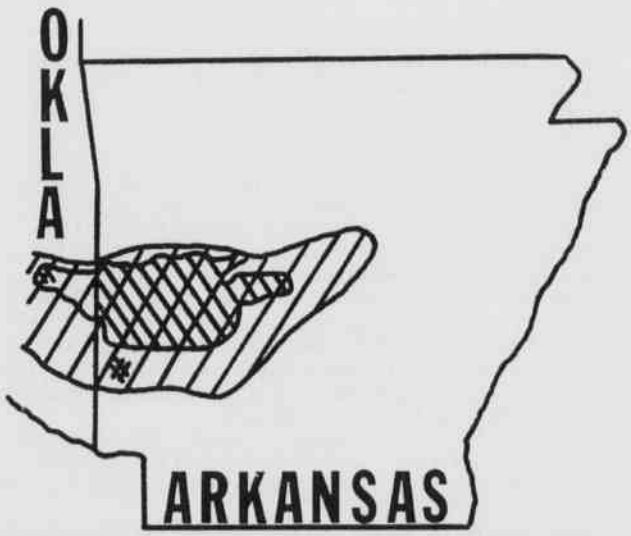

Figure 1. Location of Ouachita Mountains (backslashed area) and study area (crosshatched area).

A majority of the land within the Ouachita Mountains is owned by private timber companies and the USDA Forest Service, Ouachita National Forest. Hot Springs National Park also occurs within the region. Timber harvest activities have created a very diverse landscape, both horizontally and vertically, ranging from early successional seral stages (regeneration areas) to areas of older growth spatially arranged over the landscape.

Due to the geology of the region, solutional caves are essentially nonexistent. Bear Den caves, located in Winding Stair Mountain, LeFlore County, southeastern Oklahoma, occur in an outcrop belt of a massive sandstone unit and were formed by a number of factors, the most important being gravitational sliding and slumpage of sandstone. These caves have more than 365 meters of passageway and represent the only known caves from the study area (Puckette, 1974-75).

Additional subterranean habitat exists in the area in the form of abandoned mining drifts. Ranging from shallow test holes to extensive linear and T and L-shaped tunnels, these excavations are utilized by a variety of vetebrate species (Heath *et al.*, 1986; Saugey *et al.*, 1988c). Data from one recently discovered drift in Sevier County, Arkansas are reported in this study.

Some of the earliest information regarding distribution of bats of the genus *Myotis* in the study area were reported by Glass and Ward (1959). The bulk of the information concerning bats of the Ouachita Mountains of southeastern Oklahoma is the result of recent studies by Caire (1986), Caire *et al.* (1986), Hardisty *et al.*, (1987), and Stevenson (1986). Similarly, early studies of cave dwelling species by Sealander and Young (1955), and Davis *et al.* (1955), and more recent investigations by Heath *et al.* (1983, 1986) and Saugey *et al.* (1983, 1988a, 1988b, 1988c), have provided much additional information on the bat fauna of the Arkansas portion of the region.

The primary purposes of this study were to provide distribution and natural history data concerning the "tree bats" of the Ouachita Mountains and supplement existing cave and mine observations of bats with surface records. Additional information concerning cave and mine use is also reported.

MATERIALS AND METHODS

Collection was primarily by mist netting as described by Tuttle (1976). A total of 60 net nights (a net night is one mist net opened into the capture position for the evening's activities) was generated on 29 different dates, with one to five net nights per date. Nets of different lengths (5.5, 12.8,and 18.3m) were erected and opened into the capture position prior to dusk and checked at five-minute intervals. Actual netting periods varied from four to 10 hours depending upon time of year. Netting primarily occurred over shallow pools of third and fourth order streams and at the entrances of abandoned mining drifts. Each bat was removed from the net, and species, sex, age, reproductive condition, time of capture, and ambient temperature were recorded. In addition, one abandoned mining drift and four fracture caves known to be used as hibernacula were visited on at least one occasion during winter months to record their use. Voucher specimens were retained as necessary and are deposited in Museum of Zoology Collections at the University of Arkansas at Little Rock (UALRMZ) and Arkansas State University, Jonesboro (ASUMZ).

Assignment of bats into age classes was determined by closure of phalangeal epiphyses. Bats were designated as juveniles on the basis of small overall size, as well as visual observation of incomplete ossification of epiphyses.

Reproductive condition of males was determined by the position of the epididymides, and size and location of testes. Scrotal males were characterized by complete descent of the epididymides into pigmented sheaths dorsolateral to the tail and by the presence of enlarged testes. Females were diagnosed as pregnant by palpation of fetuses and examination of an obviously enlarged abdomen. Lactation was determined on the basis of teat examination.

RESULTS

FAMILY VESPERTILIONIDAE

Big brown bat, *Eptesicus fuscus* (Palisot de Beauvois): A year round resident, the big brown bat appears to be well distributed throughout the Ouachita Mountains, especially in towns and areas adjacent to clusters of manmade structures including pump houses, picnic pavillions, and dwellings. Abandoned mining drifts were also utilized as temporary roosts or hibernacula (Heath *et al.*, 1986; Saugey *et al.*, 1988c).

A number of maternity colonies were located during this study. The most unique maternity colony was located in Perry County in the seams between concrete sections of the dam impounding the Fourche la Fave River and creating Lake Nimrod. A colony of 30 adult females and non-volant juveniles was first observed during June 1984. According to local residents, the site had been used for a number of years. Periodic observations since 1984 have revealed continued use as a maternity site, with bats present during spring, summer, and fall.

The largest maternity colony or group of maternity subcolonies was discovered during the summer of 1984 when a bat infestation involving this species and the Brazilian free-tailed bat was recorded from a housing project in Hot Springs, Garland County, Arkansas (Saugey *et al.*, 1988a,b). Over one thousand individuals were removed and destroyed, or simply excluded from structures by a professional exterminator and Hot Springs Animal Control.

On 5 May, 1987, a maternity colony of 50 females and two males were excluded from the attic of a rental cabin at Lake Ouachita State Park near Hot Springs. Bats were collected by mist netting as they exited the cabin to begin foraging activities. Although all females were palpated and determined to be pregnant, only 23 females were weighed and forearm lengths recorded; mean weight (N = 23) was 23.25g (range: 15.25-26.0g) and mean left forearm length (N = 23) 48.6mm (range: 45.6-50.1mm). The two males weighed 12.5g and 14.5g.

The smallest maternity colony, composed of eight pregnant females (each with two fetuses) and one adult male, was discovered roosting in a small separation between a chimney and exterior wall of a home in Hot Springs on 18 May 1988. Mean female weight was 26.1g (range: 23-28.75g), and mean forearm length was 48mm (range: 45.8-50.9mm). Fetuses included 10 males and six females, and the mean weight was 2.3g (range: 0.6-3g), and the mean forearm length was 12.8mm (range: 7.2-15.1mm).

Several additional small colonies were discovered, but due to the time of the year visited, their status as maternity colonies could not be ascertained. These included a colony discovered during the renovation of an old school building in Norman, Montgomery County; a small colony in the Womble Work Center, U.S. Forest Service, Mt. Ida, Montgomery County; 15 individuals in a horse barn outside Hot Springs; and a colony of 14 males and 25 females in a pavillion at Shady Lake Recreation Area, Polk County, Ouachita National Forest. The colony at Shady Lake shared its roost with a small colony of the Brazilian free-tailed bat, *Tadarida brasiliensis cynocephala*.

Only eight specimens were captured during mist netting activities in heavily forested areas, with six of these captured in one evening. Conversely, 66 *Eptesicus* were netted over a small pool within Hot Springs National Park (Saugey *et al.*, 1988a), an area surrounded by homes, buildings, and other manmade structures.

Although over 800 *Eptesicus* were observed or examined during this study, most of these specimens were associated with the large infestation in the Hot Springs housing project. Heath *et al.* (1986) reported specimens from abandoned mining drifts in the Ouachita Mountains of Arkansas, and Caire (1986) reported 39 adults, subadults, and juveniles netted in riparian areas and at Bear Den Caves, but did not locate a maternity roost in southeastern Oklahoma.

Silver-haired bat, *Lasionycteris noctivagans* (LeConte): The first silver-haired bat reported from the study area was by Heath *et al.* (1983), when a 15.0g female was mist netted over a pool in Polk County, Arkansas on 9 October 1982. Heath *et al.* (1986) reported the occurrence of a 9.25g, scrotal male found hibernating in an abandoned Cinnabar mine in Pike County, Arkansas.

Since these reports, 10 additional individuals (nine males and one female) have been collected from the study area in Arkansas. Interestingly, all male specimens of this bat, with the exception of the specimen reported from the mine shaft, have been collected in spring. Eight of the nine males were collected between 11 April and 3 May 1987 by mist netting two localities in Garland County (representing new county records for Arkansas), and five of these eight were collected on the evening of 11 April 1987. The ninth male was collected over Brushy Creek in Polk County on 6 May 1983. None of these individuals were scrotal. Mean weight of males (N = 9) was 8.77g (range: 7.25-10.0g; SD = 0.81) and mean left forearm length (N = 8) was 41.0mm (range: 39.0-42.6mm; SD = 0.98). The single female specimen was recorded from the porch of a Garland County residence in December, 1986. Caire (1986) collected a single adult male on 22 May 1985, the first known specimen from southeastern Oklahoma.

Lasionycteris encountered during this study began to forage early in the evening. Times of capture were remarkably similar with 77% (N = 7) occurring between 2041 and 2310 hours. Fifty-five percent (N = 5) were captured between 2200 and 2240 hours.

This species may also forage in pairs or small groups (Barbour and Davis, 1969). On 11 April and 3 May, 1987, two males were netted simultaneously and within a few centimeters of one another as they flew over a pool.

Although considered to be migratory (Barbour and Davis, 1969), the occurrence of a hibernating male in January and the December occurrence of the female specimen indicate some individuals overwinter in the study area.

Red bat, *Lasiurus borealis* (Muller): The red bat was more frequently mist netted than any other species, with 386 individuals captured. Although all of our netting was conducted in riparian areas, this bat was observed to utilize almost every available foraging area from ridgetops to densely wooded timber stands, regeneration areas, powerline rights-of-way, highways, and old logging roads. This lack of preference by red bats for any particular foraging habitat was also observed by Lacki and Bookhout (1983) in the Wayne National Forest in Ohio. On several occasions during late summer and early fall, mist nets were set at the entrances of abandoned mining drifts resulting in the capture of males. Such behavior by lasiurine (tree) bats in the Ouachita Mountains may be common, especially during autumn swarming and mating activities. Cassidy *et al.* (1978) reported red bats in late summer and early autumn swarms with several species of cave-dwelling bats at the entrances of Ozark caves, and Saugey *et al.* (1978) reported the remains of 140 red bats in an Arkansas Ozark cave.

Male red bats were netted with greater frequency than females, often at a 3:1 ratio. LaVal and LaVal (1979) reported similar findings in Missouri and Saugey *et al.* (1988a) reported similar results from Hot Springs National Park, Arkansas.

Capture rates for this species were quite variable. On some occasions only one or two specimens would be captured, while on the next night, in the same general area and under seemingly similar conditions, many individuals would be captured.

On 13 August 1983, 130 red bats were mist netted over a shallow pool of Dutch Creek in Yell County. This pool was located in an open area adjacent to a low water bridge, with trees on one bank and an extensive gravel bar on the other. Temperatures recorded during netting activities ranged from 29 C at dusk to 22 C at 0130 hours of the

14th. A majority of captures occurred at a temperature of 24 C spanning a three hour period; a time probably coinciding with normal foraging. Ninety-three males and 37 females were captured in just over four hours. LaVal and LaVal (1979) observed such concentrations of red bats in Missouri during the month of July, and Baker and Ward (1967) reported similar aggregations in southeastern Arkansas during August. Such late summer/early fall concentrations of red bats may be equivalent to swarming behavior exhibited by species that frequent caves.

On numerous occasions during netting activities on 13-14 August, three or more bats would strike the net simultaneously and within a few centimeters of one another. Examination of these clusters typically revealed two or more males and one female, suggesting males may have been pursuing females for breeding purposes. Saugey *et al.* (1988a) documented similar behavior in the evening bat, *Nycticeius humeralis,* during fall netting activities in Hot Springs National Park.

Breeding activity was observed on two occasions, both of which were initiated in flight. In September, 1982, a copulating pair of red bats was observed on the parking lot of Garland County Community College in Hot Springs. The male was mounted dorsally and clenched the nape of the female's neck in his mouth, maintaining tension throughout the episode.

Information on the hibernation of red bats in the Ouachita mountains was restricted to winter (December through March) observations of specimens "smoked" from their hibernacula during prescribed burning activities on the Ouachita National Forest. Red bats were often observed on the ground, still in a state of near torpor, attempting to crawl or fly after becoming overwhelmed by smoke or perhaps stimulated into arousal by the elevated air temperatures resulting from burning leaf litter and other debris. Exact winter roost preference was difficult to ascertain since bats were observed beneath both shortleaf pine and various species of hardwood trees on both north and south aspects. However, a majority of the sightings were made on north aspects or in drainages where temperatures tend to remain cooler and more constant during the hibernation period. Selection of such sites may help conserve stored energy reserves by preventing hibernating bats from unnecessarily arousing when true ambient temperatures are below temperatures at which lasurine bats become active, as might occur on south aspects due to radiant heat. Interestingly, all red bats observed during winter months were males.

Several instances of mortality were observed during the study. The remains of numerous red bats were observed along roadways where bridges spanned streams with suitable flyways. This indicates automobiles may account for some limited mortality. Saugey *et al.* (1988a) observed attempted predation on a male red bat entangled in a mist net by the screech owl, *Otis asio,* during mist netting activities in Hot Springs National Park. One unique case of mortality was discovered when a dehydrated male red bat was found hanging from a strand of barbed wire enclosing a horse pasture near the community of Jessieville in Garland County. The barb had penetrated the uropatagium at such an angle as to preclude escape when the bat attempted to fly. Wisely (1978) reported similar observations for the hoary bat, *Lasiurus cinereus.*

Heidt *et al.* (1987) reported that between 1982 - 1986, bat rabies in Arkansas averaged 10% of animals submitted to the Arkansas Department of Health. During this period, 258 red bats were submitted for testing, and 44 (17.1%) were positive. The following counties in the Ouachita Mountains reported one or more positive red bat: Garland, Logan, Perry, Pulaski, Saline, Scott, Sebastian, Sevier, and Yell. Other species of bats which had specimens test positive from the Ouachita Mountains included: *Eptesicus fuscus* (Garland, Pulaski and Scott counties), *Nycticeius humeralis* (Pulaski County), *Lasiurus cinereus* (Logan and Pulaski counties), and *Tadarida brasiliensis cynocephala* (Garland County).

Red bats apparently communicate with one another while foraging. During mist netting activities, it was rather common for red bats to circle about and/or land on cages or pillow cases in which captured bats were constrained. This behavior has also been reported by Baker and Ward (1967) and Saugey *et al.* (1988a).

The red bat appears to be well distributed and very common throughout the Ouachita Mountains of Arkansas; having been captured in considerable numbers from Garland, Logan, Montgomery, Perry, Polk, Scott and Yell counties. Caire (1986) considered this species to be one of the most commonly encountered bats of southeastern Oklahoma.

Hoary bat, *Lasiurus cinereus* (Palisot de Beauvois): Initially reported from the Ouachita Mountains of Arkansas by Gregg (1937), the distribution of the hoary bat was greatly expanded by Heath *et al.* (1983) when specimens were reported from Logan, Montgomery, and Polk counties. Saugey *et al.* (1988a) reported the captures of a large pregnant female on 1 June 1983, and a scrotal male (20.0g) and large female (26.0g) on 26 August 1983 in Hot Springs National Park, Garland County.

During this study, 30 hoary bats (12 females and 18 males) were captured. The captures occurred primarily during two distinct periods - May/June and August/September. Similar collection dates were reported by Baker and Ward (1967) for southeastern Arkansas, Gardner and McDaniel (1978) in northeastern Arkansas, and Caire *et al.* (1986) for the Ouachita Mountains of southeastern Oklahoma. Although specimens were captured outside these periods, and specimens of the hoary bat have been recorded throughout the year in Arkansas, these capture dates appear to indicate migration through the area; Zinn and Baker (1979) have discussed the migratory character of this bat.

Six of the 12 females captured were pregnant. On 6 May 1983, a pregnant female weighing 34g was captured; three weeks later on 28 May, four pregnant females with a mean weight of 33.8g (range: 32.0-35.5g) were mist netted while foraging over a stream; and on 5 June 1984, a pregnant female was captured that weighed 35.0g. Females captured during other times of the year included: 5 September 1982 (28.0g); 26 August 1983 (27.0g); and 19 April 1987 (29.0g). Caire *et al.* (1986) reported the capture of a pregnant female (containing a single well developed embryo) in late May and a lactating female in mid-June.

Two non-scrotal males were mist-netted during spring and early summer. One of these males, captured on 19 April, weighed 19.6g and the other, taken on 15 June, weighed 28.0g. The remaining 16 males, captured primarily in late August and early September, ranged in weight from 19.5g to 31.0g and included both mature adults and young of year. All males captured during this period were either partially or fully scrotal.

Although considered a tree bat (Barbour and Davis, 1969), a male hoary bat was netted at the entrance of an abandoned mine in Polk County on 3 September 1982 (Saugey *et al.,* 1988c). Occurrences of this species in caves of the Ozark region of northern Arkansas have been previously reported (Grove 1974, Saugey *et al.,* 1978).

Caire *et al.* (1986) refuted the description of this species as a late flyer by documenting capture times. They found times varied from 2055 to 0440, with 69% of specimens captured prior to 2400 hours and 38% prior to 2200 hrs. While exact time of capture was not recorded for all specimens in this study, our data (N = 13) support their contention in that 76% (N = 10) of our specimens were captured prior to 2400 hours and 38% (N = 5) of these were captured before 2200 hours. Time of capture ranged from 2040 hours to 0123 hours. Nets were monitored continuously while in the capture position, but were not left up all night.

This bat was recorded from Garland, Montgomery, Polk, Scott, and Yell counties.

Seminole bat, *Lasiurus seminolus* (Rhoads): First reported from Arkansas by Sealander and Hoiberg (1954), this bat was considered to occur in the Gulf Coastal Plain over most of the southern two tiers of counties (Baker and Ward, 1967; Sealander, 1979; Hall, 1981). Heath *et al.* (1983) reported the capture of an adult female (3 September 1982) at the entrance of an abandoned mining drift in Polk County, extending the range of this species 57km north of its previous marginal records and into the Ouachita Mountain area of the Interior Highlands. Since that time, four additional specimens were captured in Arkansas during the summer of 1983.

On 30 July 1983, a scrotal male was mist-netted over a pool of Jack Creek in Jack Creek Recreation Area, Logan County (T4N-R27W-SO2). This specimen extended the range of the species approximately 71km

north of the 1982 location (ASUMZ # 10363). On 13 August 1983, two scrotal males (ASUMZ #'s 10393/10394) were netted among a large aggregation of red bats (previously discussed) over a pool of Dutch Creek in Yell County (T4N-R25W-S29). A scrotal male was captured, along with 45 red bats, over a pool of Blocker Creek in Garland County (T1N-R21W-S34) on 27 August 1983. This capture was made approximately 83km east/northeast of the initial mine entrance record and was still far north of specimens previously reported in the literature. These additional records have greatly expanded the known range of this species within the Ouachita Mountains of Arkansas (Fig. 2).

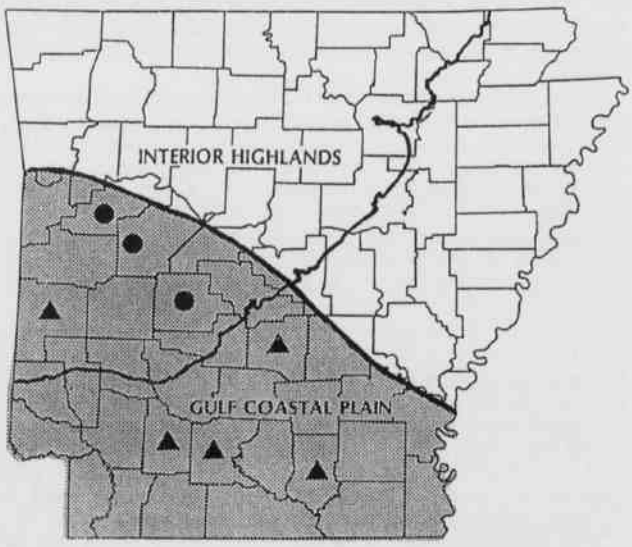

Figure 2. Arkansas distribution of the seminole bat *(Lasiurus seminolus)*. Triangles represent counties with previously published records; circles represent counties from which bats were taken in this study.

Southeastern bat, *Myotis austroriparius* (Rhoads): The first specimens of the southeastern bat collected in Arkansas came from the Ouachita Mountains when Davis *et al.* (1955) reported the occurrence of this bat from an abandoned mining drift in Garland County. Heath *et al.* (1986) reported the occurrence of a hibernating colony (numbering 150 individuals of both gray and red color phases) from an abandoned Cinnabar mine on a peninsula in Lake Greeson, Pike County. On 16 January 1989, a hibernating colony of 15 individuals of both sexes and color phases was found in an abandoned mine in northern Sevier County, Arkansas, in the Athens Plateau subdivision of the Ouachita Mountains. Suitability of this mine as a hibernaculum was apparently due to multiple entrances that provided continuous movement of air and an internal temperature several degrees cooler than that found in mines with single openings (14.4 - 16.6 C). The hibernaculum was shared with 30 *Pipistrellus subflavus* and five *Eptesicus fuscus*.

Caire (1986) did not capture this species in the Ouachita Mountains of southeastern Oklahoma, although this bat was recorded from the area by Glass and Ward (1959). Steward (1988) and Steward *et al.* (1986) reported additional specimens of this bat from Arkansas counties within and adjacent to the study area. The Southeastern bat is listed as a Category 2 candidate for possible listing as a threatened or endangered species in the U.S. Federal Register (1989).

Small-footed bat, *Myotis leibii* (Audubon and Bachman): Only one specimen of the small-footed bat was known from the Ouachita Mountain region (Hall, 1981) until Caire (1986) and Stevenson (1986) reported captures of six individuals from Bear Den Caves in LeFlore County of southeastern Oklahoma during the summer and fall. McDaniel *et al.* (1982) stated this species was the rarest and least known bat in the southern Ozarks, where caves are plentiful, and Caire (1986) stated this bat was probably restricted to cave areas and the paucity of caves in southeastern Oklahoma make the few caves there critical to its survial and presence in the area.

Heath *et al.* (1986) did not encounter this species during investigations of abandoned mining drifts. This bat's habit of hibernating in drafty open mines and caves may render most abandoned mines in the Ouachita Mountain region unsuitable due to their relatively warm temperatures (15-16.5 C) and restricted air movement. Steward *et al.* (1986) did not report this species from the caveless region of southwestern Arkansas.

On 19 January 1989, five individuals were observed hibernating in Bear Den Caves. All roosted solitarily in relatively restricted areas of cave breakdown. Temperatures at roost sites varied from 9.5 to 15 C. Two individuals (a male and female) were examined: the male weighed 4.5g and had a left forearm measurement of 33.7 mm. The occurrence of these bats in summer, fall, and winter indicates this species is found in the study area throughout the year. The small-footed bat is a Category 2 federal candidate species.

Little brown bat, *Myotis lucifugus* (LeConte): Sealander and Young (1955) first reported the occurrence of this bat from specimens observed in an abandoned mine in Garland County. Heath *et al.* (1986) reported a single male specimen from a different mine in Garland County. During this study, only one little brown bat, a female, was captured in a mist net at 2120 hours on 30 July 1983 over a pool of Jack Creek, Logan County. One additional specimen, a male, was found hibernating with a small cluster of the endangered Indiana bat *(Myotis sodalis)* on 16 January 1989, in Bear Den Caves, LeFlore County, southeastern Oklahoma. Glass and Ward (1959) reported one specimen from southeastern Oklahoma, but extensive work by Caire (1986) and Stevenson (1986) failed to document additional specimens from the area.

Keen's bat, *Myotis keenii* (Merriam): Thirteen Keen's bats (11 males/2 females) were mist netted from locations in Garland, Montgomery, Polk and Yell counties. These sites are widely spaced and probably indicate the species is well distributed over the area even though rarely encountered.

Heath *et al.* (1986) reported this species from 12 different abandoned mining drifts in the Ouachita mountains. The largest hibernating aggregation consisted of 12 bats and the largest group encountered at other times of the year was a group of 57 pregnant females. Sealander and Young (1955) also reported this species from an abandoned mining drift.

An adult male, mist netted on 6 May 1983, weighed 7g. Additional adult and subadult males, mist netted in riparian areas and at the entrances of abandoned mines in September and October, ranged in weight from 5.5-7g, and all were scrotal. Two postlactating females were captured on 16 July 1983.

Occurrence of Keen's bat in the Ouachita Mountains of southeastern Oklahoma was originally reported by Glass and Ward (1959). Stevenson (1986) and Caire (1986) reported the capture of a total of 328 adults, subadults, and juveniles from riparian areas and cave entrances in southeastern Oklahoma.

Indiana bat, *Myotis sodalis* (Miller and Allen): The Indiana bat was not mist netted during this study, nor was it reported from abandoned mining drifts (Heath *et al.*, 1986). Although reported from a cave in Pushmataha County in southeastern Oklahoma by Glass and Ward (1959), neither Caire (1986) nor Stevenson (1986) reported this species from southeastern Oklahoma after extensive mist netting of riparian areas and examination of caves and buildings.

On 16 January 1989, a hibernating cluster of seven Indiana bats was discovered in Bear Den Caves, LeFlore County, Oklahoma. The cluster, composed of both males and females, and a single male *Myotis lucifugus*, was located six meters above the cave floor where the air temperature was 9.5 C.

Indiana bats may have used these caves as hibernacula in previous winters, but may have gone undetected because the two major studies of the bat fauna in southeastern Oklahoma were conducted in summer and fall (Caire, 1986; Stevenson, 1986). In addition, mist netting of riparian areas may not result in the capture of this bat which was shown

to forage extensively in forested hillsides and ridgetops in Missouri (LaVal *et al.*, 1977; LaVal and LaVal, 1980).

The discovery of this hibernating cluster may indicate the occurrence of this species in the Ouachita Mountains during other times of the year, although females are known to travel considerable distances from hibernacula to maternity sites (LaVal and LaVal, 1980). Recent investigations of habitat utilization by this species in Illinois (Gardner *et al.*, 1989) revealed use of living red oak, white oak, post oak, and hickory trees as roost trees, and use of a shagbark hickory snag as a maternity site; all of which occur in the Ouachita Mountains. The need to retain existing snags, together with the creation of snags with large diameters, have been addressed in the draft Land and Resource Management Plan for the Ouachita National Forest (USDA Forest Service, 1989).

Evening bat, *Nycticeius humeralis* (Rafinesque): A total of 158 evening bats was examined from the study area. Twelve were mist netted in riparian areas, and the remainder occurred in two maternity colonies located in the attics of older homes in Hot Springs.

Specimens mist netted in forested areas included 10 males and two females collected from widely spaced areas in Garland, Logan, Montgomery, Perry, Polk, and Scott counties. Two of these males, collected in May, weighed 8.5g and 10g, and a subadult male collected in July weighed 9g. Males collected in September weighed 12g, 13g, and 14g and a subadult male weighed 9.75g. One of the two females captured was pregnant and weighed 13.0g.

The largest of the two maternity colonies was examined on 15 July 1982, and contained an estimated 150 individuals. A total of 109 individuals (39 adult females, 37 juvenile females, 33 juvenile males) was captured, examined, and released. Several adult females were still lactating and all juveniles were volant.

The smaller maternity colony, estimated to contain 100 individuals, shared their maternity site with a maternity colony of *Tadarida brasiliensis cynocephala* (Saugey *et al.*, 1983). Initial examination of the site on 11 June 1983, revealed a number of pregnant females. Although many bats were present, only four could be captured due to the inaccessible nature of the roost. Weights for these pregnant females were 10.5g, 11.5g, 11.75g, and 12.25g. A female that gave birth while we were in the roost weighed 8.25g immediately after parturition. Two newborns, one male and one female, both weighed 2.25g and had left forearm lengths of 17mm. When re-examined on 1 July, both volant and non-volant juveniles were present. Seven non-volant males had left forearm lengths (LFA) ranging from 28-32mm, and weighed from 4.5-5.5g. Non-volant females (N = 3) had LFA ranging from 27.3-33mm, and weighed 4.25-6.5g. Volant juvenile males (N = 3) had LFA measurements ranging from 31-33.5mm, and weighed 5-6.5g. Volant juvenile females had LFA measurements ranging from 31.9-35.2mm, and weighed 5.5-6.75g.

This colony was observed for the final time on 13 July when most juveniles were observed to be volant and very difficult to capture. Seven juveniles were captured, however, five of which were volant. One non-volant juvenile male had a LFA measurement of 34.6mm; one non-volant female had a LFA measurement of 36.8mm; three volant juvenile males had LFA measurements ranging from 31.5-34.8mm; two volant females had LFA measurements of 34.9mm, and 36.8mm. Three post-lactating adult females were captured and weighed 8g, 10g, and 10.5g. Some females were presumed still to be lactating as evidenced by the presence of non-volant young. The simultaneous occurrence of volant and non-volant young during the period 1 July through 13 July, and presumably beyond for several more days, indicated parturition within the colony was protracted.

Eastern pipistrelle *Pipistrellus subflavus* (F. Cuvier): The eastern pipistrelle may be the second most common bat species in the forested areas of the Ouachita Mountain region. Caire (1986) found this bat to be fairly abundant in eastern Oklahoma, and Stevenson (1986) reported significant numbers of this species captured using mist nets and Tuttle traps (Tuttle, 1974) at Bear Den Caves. Heath *et al.* (1986) reported this bat from every abandoned mining drift at all times of the year with one mine harboring 600-800 hibernating individuals annually.

During this study, 39 eastern pipistrelles (26 males/13 females) were mist netted over pools in riparian areas and at abandoned mining drift entrances. The largest number captured in any one evening was six, and on numerous occasions none were captured even though other species were numerous.

Adult males weighed as little as 4g in early April (upon emerging from hibernation) and 6g in early fall. Adult females weighed 5.25g in early May, and a pregnant female captured 15 June 1984 weighed 7.75g.

FAMILY MOLOSSIDAE

Brazilian free-tailed bat, *Tadarida brasiliensis cynocephala* (I.Geof. St-Hilaire): The Brazilian free-tailed bat has been found in two widely spaced localities within the study area. Saugey *et al.* (1988b) reported on the distribution and status of this species in Arkansas. This study included a major infestation of an apartment complex by this species and *Eptesicus fuscus* in Hot Springs, and the occurrence of a small colony located in the main pavillion area of Shady Lake Recreation Area, Ouachita National Forest, Polk County. Saugey *et al.* (1988a) also reported mist netting seven specimens in Hot Springs National Park.

Hardisty *et al.* (1987) captured 39 specimens at an apparent maternity site in the Forest Heritage Center building in Beavers Bend State Park, McCurtain County, Oklahoma, and Steward *et al.* (1986) reported specimens from several Arkansas counties south of the study area.

This species appears to be closely associated with man, readily utilizing suitable manmade structures. Interestingly, this species was not mist netted in riparian areas nor was it found to use abandoned mining drifts (Heath *et al.*, 1986).

DISCUSSION

Data reported in this and other studies of the area demonstrate that the Ouachita Mountain region has a rich and diverse bat fauna represented by 13 different species. Undoubtedly, the diversity of habitats found within the Ouachita Mountains (including vertical and horizontal distribution of different seral stage conditions, mixtures of pine, hardwood, and pine-hardwood mixed forest types, plentiful water and associated riparian areas, caves, and abandoned mines) contributes to an abundance of suitable foraging, hibernating and roosting sites. sites.

The bat fauna represent an integral component of Ouachita Mountain ecology. Most species are currently represented by fairly wide spread and adequate populations; however, the Indiana bat is endangered, and the southeastern and small-footed bats are Category 2 federal candidates for possible listing as threatened or endangered species. Bats, particularly those inhabiting caves and mines, represent an extremely vulnerable faunal element (Saugey *et al.*, 1988c). Protection of caves, abandoned mining drifts, and associated epigean habitats, and their designations as "key" wildlife habitat components have been recommended by Caire (1986) and Saugey *et al.* (1988c). The importance of these habitat types to bats and their disproportionate use have been discussed by Gates *et al.* (1984) and Maser *et al.* (1979).

Presently, 13 of the estimated 58 species of mammals believed to occur within the Ouachita Mountain region are bats, representing a significant component (22%) of the mammalian fauna. Clearly, marginal habitats of importance to bats such as caves and abandoned mines, and diverse and spatially distributed forest types and age classes, appear to have contributed to the rich bat fauna of the region. Protection, maintenance, and enhancement of these habitat components must be considered in all phases of planning and implementation of management activities in the Ouachita Mountain area.

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